International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)
ISSN(P): 2249-6866; ISSN(E): 2249-7978
Vol. 7, Issue 3, Jun 2017, 1-8

EXPERIMENTAL INVESTIGATION ON BITUMINOUS MIX USING COCONUT COIR

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ABSTRACT

A pavement structure can be divided in to two types flexible pavement or a rigid pavement based on its structural behavior. In India due to its advantages over rigid pavements and economy, flexible pavements are widely preferred here. Bituminous concrete mixes are the structurel layer used widely in Flexible pavements. The property of bituminous mixes can be enhanced by addition of fibres such as coir fibres. Fibre lengths were kept i.e. 15mm and used at the rate of 0.3%, 0.5% and 0.7% by weight of mix. In this project, Marshall method of mix design was taken in to consideration for the mixes and the project studies the stability of coir as a reinforcing material in bituminous mixes. The optimum bitumen content and fiber content is analysed for the coir fiber and their performances is determined. An optimum bitumen content of 5%, optimum fibre content of 0.3% and fibre length of 15mm was obtained after analysis. On doing a study on the Marshall parameters, it is found that the augmentation of coir fibre to SDBC mix contributes significantly in enhancing the performance of the mix.

KEY WORDS: Bitumen, Coir Fibre, Marshall Mix Design, Semi-Dense bituminous Concrete & Stability and Flow

Received: Mar 22, 2017; **Accepted**: Apr 08, 2017; **Published**: Apr 20, 2017; **Paper Id.**: IJCSEIERDJUN20171

A Review Article

INTRODUCTION

Flexible pavement have small or insignificant flexural strength and are rather flexible in their structural action beneath the loads. These pavements are layered structures with the subsequent element layers.

- Soil sub-grade
- Sub base
- Base Course
- Surface Course

The coated pavement structure transmit vertical or compressive stress to the inferior layers by grain to grain transfer through the points of contact in the grainy structure with strong graded aggregates and should transfer the compressive stress to a wider area. In light of the above factor it can be learnt that bituminous mix is one of the top flexible pavement coat materials. Bituminous mix is usually used as a outside course and wearing course in flexible pavements since it is necessary that the wearing course must afford a smooth riding surface that is thick and at the similar time take up wear and tear due to traffic.

The early failure of flexible pavement is due to early growth of distress like cracking, rutting, bleeding etc. The incorporation of fibre in the mix improve the mechanical property. In India about 8 lakh tonnes of coir

fibre is being generated and is used for various products, the residual waste fibre is discarded in open terrain causing solemn environmental contamination. Therefore, a study has been undertaken to exploit the waste fibre as reinforcement in bituminous concrete.

LITERATURE REVIEW

T.SUBRAMANI: Has investigated on coir fiber in bituminous mix of 4 %,5%.6% bitumen and 10mm,15mm,20mm coir length of different percentages are added to improve the mix and increase the stability. The stability value has been increased by 1.3 times when compared to the nominal and flow with an increment of 1.8 times.

MS. P.BAIKIYA and **C. KAMARAJ:** Has investigated on different proportions of coir i.e, 0.3%,0.5%,0.7% of different length are added in bituminous mix to increase the stability, indirect tensile strength test, short and long term ageing test and stiffness modulus test are investigated to achieve the optimum binder content.

EXPERIMENTAL WORK

Material Characterization

Aggregates

The coarse aggregate used was a normal weight aggregate with a maximum size of 10 mm and minimum size of 2.36mm as coarse aggregate, Stone dust was used as the filler.

Table 1: Material Characteristics of Aggregate

S. No.	Test	Morth Speciication	Test Values		Test Method
1.	Impact Value(%)	<30	28.84		IS 2386 Part IV
2.	Crushing value (%)	<30	25.45		IS 2386 Part IV
3.	Specific Gravity test	2.5-3	10mm Aggregate	2.71	IS 2386 Part III
			2.36mm Aggregate	2.67	
			Stone Dust	2.61	
4.	Water Absorption	<2	1.01		IS 2386 Part III

Bitumen

60/70 grade of bitumen is used as the binder and its properties as determined by standard test procedures are tabulated.

Table 2: Test on Bitumen

S. No.	Test	Permissible Values	Test Values	BIS Test Method
1.	Penetration value 25ºc	50-70	64	IS 1203- 1978
2.	Softening point, ºc	>50	57	IS 1205- 1978
3.	Ductility value at 27ºc, cm	>75	94	IS 1208- 1978
4.	Specific gravity	>0.99	0.9	IS 1202- 1978

Coir Fibre

Figure 1: Coir

The investigation on coir reinforced bituminous mixes. The coir was obtained in bundles and then cut to the required lengths of 15 mm.

Table 3: Properties of Coir Fiber

Property	Value
Diameter (mm)	0.1-0.3
Density (g/cm^3)	0.68-10.0
Natural moisture content (%)	11.44-15.85
Water absorption (%)	86-135
Tensile strength (MPa)	106.26-252.90
Modulus of elasticity(GPa)	2.6-4.5
Strain at failure (%)	13.6-41.0
Specific Gravity	0.57
Water Absorption (%)	74.47
Bitumen Adsorption (%)	106.14

PROPORTIONING OF AGGREGATES

Semi Dense Bituminous Concrete

Semi dense bituminous concrete mix grade 1 as prescribed by Ministry of Road Transport and Highways (Mo RTH) in stipulation for Road and Bridge was chosen as the bituminous mix.

Table 4: Physical Requirements for Coarse Aggregate in SDBC Grade 1

Property	Test	Value (%)
Cleanliness	Grain size Analysis	5 Max. passing 0.075mm sieve
Strength	Aggregate Impact Value	27 Max.
Water absorption	Water absorption	2Max.
Stripping	Static Immersion Test	95 min. retained coating

Table 5: MORTH Specified Gradation for Aggregates in SDBC

IS Sieve in mm	Required %Passing	Upper Limit	Lower Limit	Average Value
13.2	90.100	100	90	95
9.5	70-90	90	70	80
4.75	38-51	51	35	43
2.36	24-39	39	24	31.5
1.18	15-30	30	15	22.5
0.3	9-19	19	9	14
0.075	3-8	8	3	5.5

This generally consists of construction in a single or multiple layers of SDBC on a earlier prepared bituminous bound surface. A single layer is 25mm to 100mm in thickness. The table gives some of the necessities for the physical properties of the aggregates used in SDBC grade 1. The mandatory gradation of the aggregates for semi dense bituminous concrete grade 1 as given in the MoRTH specifications is given in Table.

Proportioning for SDBC Grade 1

After proportioning the aggregates for semi dense bituminous concrete mix as per MoRTH provision the following mix proportion was obtained.

13.2 mm aggregate: 60%

4.75 mm aggregate: 20%

Stone dust: 20%

The gradation of the above mix proportion is given in T

Table 6

IS Sieve in mm	10mm	2.36mm	Dust	Proportioned Value	Required Value	Acceptable Range
13.2	100	100	100	100	95	90-100
9.5	72.3	100	100	88.32	80	70-90
4.75	1.3	100	100	60.48	42	35-51
2.36	0.6	15	100	30.8	30.5	24-39
1.18	1.6	1.6	74.2	18.60	21.5	15-30
0.3	0.4	1.2	48.6	12.06	13	9-19
0.075	0.4	0.7	15.6	4.36	5.55	3-8
Proportion (%)	60	20	20			

Marshall Method of Mix Designing

Marshall Test is utilized for the bituminous mix design as per Indian MoRTH recommendation.

Marshall Test is essentially an unconfined compression analysis where load is applied to a cylindrical specimen of bituminous mix and the sample is monitored till its failure. The conflict to plastic deformation of the cylindrical specimen of bituminous mix is considered when loaded at the periphery at 5 cm per minute. Stability & flow, mutually with density, voids and percentage of voids filled with binder are determined at unreliable binder contents to obtain an 'optimum' bitumen content for fatigue resistance, stability, flexibility, durability. etc.

The Marshall method of mix design essentially consists of the following three stages.

- Bulk Density determination
- Stability and Flow test
- Density and Voids analysis

The procedure for preparation of specimens for the Marshall test: A total of 24 specimens were prepared and tested in addition to the reference mix.

Weighing of Materials

- The materials for the sample viz. aggregates of three different sizes, 10 mm, 2.36 mm and stone dust, 60/70 grade bitumen and coir fiber of 15mm length were weighed according to the proportioned values for the various mixes.
- **Weighing of Materials:** Here the materials i.e. aggregates of three different sizes the 10 mm, 2.36 mm and stone dust, 60/70 grade bitumen and coir fiber of required length were weighed according to the proportioned values for the various mixes.
- **Heating of Aggregates**: Aggregates of the required gradation were mixed in a pan. The coir was also added to the aggregates and mixed well to ensure uniform distribution of fiber. The entire mixture was heated to a temperature of 150-160°.
- **Addition of Bitumen:** The weigh bitumen for a sample was added to the heated aggregate mix. The bitumen was heated to a fluid state and assorted well with the aggregates to get a homogenous mixture at 160-170°C
- **Pouring into Mould**: The homogenous bituminous mix was poured into the mould for compaction at 160-170°C to ensure compaction was done at 150°C. The cylindrical moulds with an inside diameter of 101.7 mm and a height of 76.2 mm, base plates, and extension collars shall conform to ASTM D1559 -Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus
- **Compaction of Specimen:** The specimen was compacted with 75 blows to each side of the cylindrical sample mounted on a standard mould assembly with a standard Marshall hammer that has a circular tamping face and a sliding weight of 4.536 kg with a free fall of 45.7 cm to get the Marshall Compaction Specimen. The compacted specimen was permitted to cool down to room temperature prior to extraction of the sample.





Figure 2: Sequential Step by Step Process of Bituminous Mix Mould

Table 7: Marshall Test Results

Mix. No.	% Bitumen	% Fibre	Coir Length mm	No. of Samples	Stability	Flow	Bulk Density	Theoretical Density	Volume of Voids	VMA	VFB
1.	5	-	-	3	18	3.57	2.68	2.47	1.21	13.50	85.34
2.	5	0.3	15	3	21	3.43	2.65	2.35	4.47	15.75	72.06
3.	5	0.5	15	3	19	5.25	2.63	2.30	4.95	15.96	68.98
4.	5	0.7	15	3	17	5.23	2.61	2.24	9.31	18.46	49.5
5.	4.5	-	-	3	14	4.00	2.68	2.39	3.23	14.8	78.17
6.	4.5	0.3	15	3	13	4.14	2.68	2.35	4.8	16.25	70.64
7.	4.5	0.5	15	3	11	4.38	2.68	2.30	7.2	18.04	60.00
8.	4.5	0.7	15	3	06	6.29	2.67	2.26	9.2	19.1	51.83

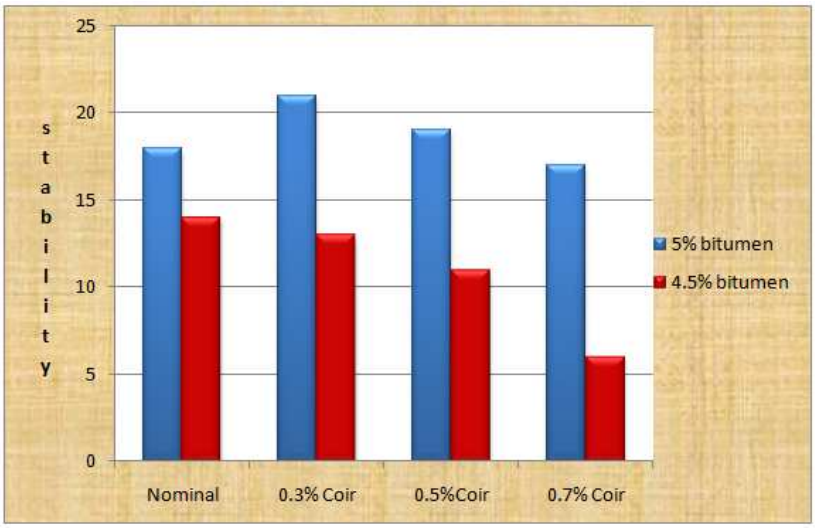

Figure 3: Binder Content Vs Stability for Mix

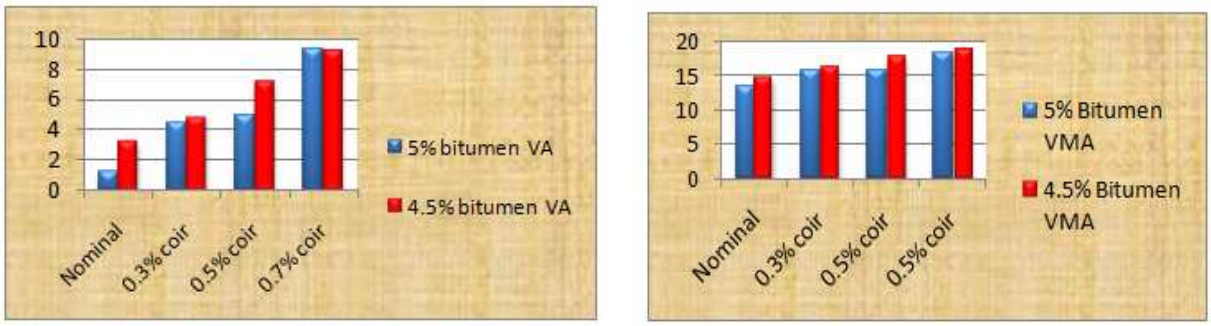

Figure 4: Comparison of Air Voids and VMA with Bitumen Content

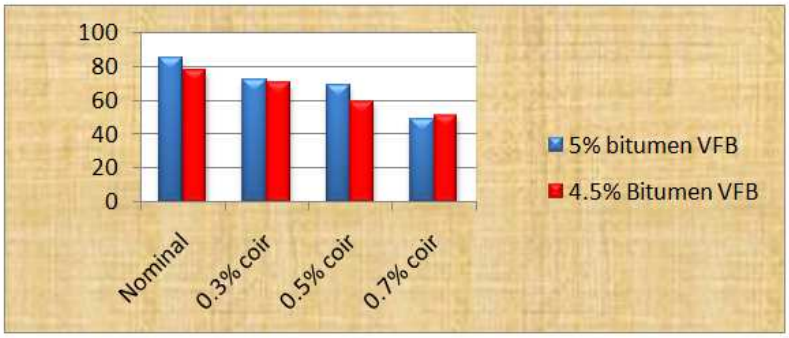

Figure 5: Comparison of Bitumen Content and VFB

From the above table 7 and figure 3,4,5 it is observed that 5% bitumen with 0.3% coir has achieved an increase in stability and flow has been decreased compared to conventional mix. The outcome of the study indicated that the adapted mixture have a higher stability. This would definitely persuade the rutting resistance of these mixtures.

CONCLUSIONS

- Adopting the Marshall method of mix design the mix volumetric were computed along with tests for Marshall stability and flow. The optimum bitumen content and its corresponding parameter were resolute for the reference mix. The optimum bitumen content, optimum fibre content were computed for the coir fibre reinforced bituminous mix.
- Adding of coir fibre to SDBC mix contribute drastically in improving the performance of the mix. Stability rate increases when compared to the reference mix making the mix more steady for the traffic load.
- The strength and void parameters of the coir fibre also meet the requirements of condition for Road and Bridge Works, MoRTH.
- No considerable variation in the optimum bitumen content was analyzed even with adding up of coir fibre. The OBC for coir fibre reduced by 8.9% when compared to the nominal mix. With this, we can conclude that additional bitumen is not required to prepare fibre reinforced SDBC mix.
- The addition of 0.3% fibre is found to be the optimum fibre content in SDBC
- The Marshall Stability value of SDBC with optimum fibre content was found to be 21 KN, which is higher than the prescribed value of 18 KN.

- The flow value of SDBC with 0.3% fiber and 15mm length fibre was found to be 3.42 mm where as the flow value for conventional mix 3.5

ACKNOWLEDGMENT

The authors wish to thank Syed Eashan Adil, HOD of civil department and Aurora Engineering College for their kind support, valuable guidance and providing all facilities for conducting this experiment.

REFERENCES

1. *Thulasirajan k, V L Narasimha 2011, "Studies on coir fiber reinforced bituminous concrete". International Journal of Engineering Research and Applications (IJERA). volume 06. Pp 835-838.*
2. *Subramanian T, 2012, "Experimental Investigation on coir fiber reinforced Bituminous mixes" International Journal of Engineering Research and Applications (IJERA), volume 2, pp 1794- 1804.*
3. *Thulasirajan k, V L Narasimha 2011, "Studies on coir fiber reinforced bituminous concrete". International Journal of Engineering Research and Applications (IJERA). volume 06. Pp 835-838.*
4. *Panda, N. (2010) Laboratory Investigation on Stone Matrix Asphalt using Sisal Fibre for Indian Roads B.Tech. Project, India.*
5. *MoRTH, Specifications for Road and Bridge Works, Upgradation of Third Revision, Ministry of Road Transport and Highways.*
6. *IS 73-2006, Paving Bitumen – Specifications, Third Revision, Bureau of Indian Standards.*